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Abstract

A new method for measuring brittle fracture in reactor
vessel steels

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From a statistical evaluation of twinning resulting from brittle fracture in steel it could be concluded that the preferred directions of twinning in this case were similar to the preferred twinning directions in shockloaded specimens.

From this similarity of twin-directions it was concluded that a running brittle fracture in steel creates stress waves. Such an emission of stress waves by a brittle fracture, however, seems only conceivable if the fracture propagates by discrete steps.

Under Euratom contract it was possible for us to verify this point of view by applying ultra high speed photographic methods for the recording of brittle fracture phenomena in steelplates.

These experiments were performed with the aid of an AVCO Streak Camera and a Barr & Stroud Framing Camera.

The results of these experiments confirmed the hypothesis of intermittent brittle fracture propagation in steel. The propagation of a brittle fracture in steel proceeds as a sequence of alternatively sudden fracture steps and halting times.

Also the dynamic stress pattern at the tip of the moving brittle fracture and the emitted stress waves could be recorded, when a sheet of photostress material was glued to the steel plate.

The distances between the observed successive stress waves are in agreement with those calculated from the fracture step lengths and halting times.

The emitted stress waves have a peak pressure of about 15 Kbar and a half time width of 5 μ sec. Similar shock waves were produced in an artifi-

dial way and transferred through small cylindrical steel specimens (6 mm diameter, 6 mm length).

It was found that by measuring the energy absorption of such a shock wave at various temperatures a reasonable estimation could be made of the isothermal Robertson stop temperature.

This isothermal Robertson stop temperature is an important steel property in the qualification of reactor vessel steels.

It is now possible to determine the influence of radiation damage on the isothermal Robertson stop temperature with the aid of shock wave damping measurements which require only very small specimens.